

## **THERMO-RESPIRATORY RESPONSES OF NATIVE AND EXOTIC SHEEP BREEDS TO SUBTROPICAL HOT SUMMER IN EGYPT**

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### **SUMMARY**

This work was carried out to compare the response of rectal temperature, respiration rate and blood bicarbonate of Egyptian Rahmani sheep and Merino under rising summer midday temperature from (30°C to 36°C). Five rams at 8m. and at 16m. of age of both breeds were used. The increase in ambient temperature caused more increase in body temperature of Merino than Rahmani 0.6 vs 0.4°C. Respiration rate showed immense breed difference increasing from 40 to 60 respirations/min. in Rahmani compared to 80 to 116 in Merino at 8 m. of age. The respective Valuse for 16m. old rams were 30 to 50 vs. 69 to 100. Blood bicarbonate (HCO<sub>3</sub>) decreased in negative response to the increase of respiration rate steadily in Rahmani while in Merino it decreased with respiration rise up to 110 Respirations/min. thereafter it increased parallelly with further increase in respiration rate.

The composite thermo-respiratory response is discussed in concern of "acid-base" balance and maintenance of normal blood pH.

**Keywords:** Sheep, thermo-respiratory response

### **INTRODUCTION**

Extensive importation of temperate sheep breeds to Egypt was adopted since the fiftieth of this century to improve sheep productive performance (prolificacy, growth rate and wool quality). Anyhow, the performance

of these exotic breeds was not satisfactory particularly during summer. High ambient temperature in summer creates physiological stress involving unfavourable metabolic disturbance. Under such high ambient temperature the temperate zone sheep breeds display an increase in body temperature and respiration rate as well (Azamel, 1984; Shalaby, 1985; Khalifa et al., 1987 and El-Ganaieny, 1986).

These responses induce variations in the internal body physico-chemical conditions (temperature, osmosis and pH) Respiratory system plays an important role in controlling changes in these conditions due to low efficiency of sweat glands (Brook and Short, 1960) and heavy wool coat which impairs heat dissipation via skin surface. High frequency of respiration rate results in hyperventilation which is apt to cause depletion of  $\text{CO}_2$  from the body and in blood consequently induce alkalosis case.

The present study was carried out to compare between subtropical Egyptian Rahmani sheep breed and the temperate zone Merino sheep in their physiological activity concerning their adaptability to the prevailing summer ambient temperature in Egypte.

#### MATERIALS AND METHODS

The present experiment was carried out in Animal Production Department, Faculty of Agriculture, Cairo University, Egypt to study the effect of summer (July and August) prevailing ambient temperature on thermo-respiratory reactions of native and exotic sheep. Five rams from Egyptian Rahmani and Merino at each of 8 and 16 month of age were used in this study. Animals were raised under common managerial practices of housing and feeding in the farm.

The tested physiological reactions included body temperature (BT), respiration rate (RR) and blood plasma bicarbonate ( $\text{HCO}_3^-$ ) content on one day at 12.00-15.00 h at weekly intervals in four consecutive weeks. Air temperature (AT) was recorded by a thermometer under the shed where animals were kept. The response of the animals was determined at selected ambient temperatures of 30, 32, 34 and  $36^\circ\text{C}$  within that midday period. Body temperature was measured by a clinical thermometer from rectum. Respiration rate was determined by counting the

flank movements for one minute. Blood samples from each animal were collected from Jugular vein under neutral paraffin oil (to avoid contact with air) in oxalate coated tubes. The tubes were centrifuged at 3000 r/min. to determine blood plasma bicarbonate by the titration method after Oser (1965) indicated by  $\text{CO}_2$  concentration.

Statistical analysis was carried out according to Snedecor and Cochran (1982).

#### RESULTS AND DISCUSSION

Under different ambient temperatures at different ages, the rectal temperature of Rahmani was less than that of Merinos by 0.2-0.4°C (Table 1). The increase in rectal temperature with rise in ambient temperature was almost equal in the two breeds with greater value in eldest animals (Table 1). Results of the present study indicated that rectal temperature increases in narrow range with ambient temperature elevation which is in agreement with the findings of Abdelazeem (1984), Azamel (1984) and Khalifa et al. (1987).

Table 1. Body temperature (°C) of Rahmani (Rah) and Merino (M) at 8 and 16 months of age under different ambient temperatures

Ambient temp. °C	Age/breed			
	8		16	
	Rah	M	Rah	M
30	39.4±0.3	39.6±0.2	39.2±0.2	39.4±0.3
32	39.5±0.2	39.8±0.2	39.4±0.2	39.6±0.3
34	39.6±0.2	40.0±0.2	39.5±0.3	39.8±0.3
36	39.8±0.1	40.2±0.3	39.7±0.3	40.0±0.3

Merino acquired double rate of respiration compared to Rahmani under different air temperatures and at 8 and 16 months of age (Table 2). Variation in respiration rate among individuals was greater in Merino than Rahmani. Respiration rate was higher, in both breeds, in young

than old animals. Respiration rate increased steadily, with rise in ambient and rectal temperature.

The acceleration of increase in RR was faster between 30 and 32°C, thereafter the acceleration showed downward deflection before increasing again at 36°C (Table 2).

Table 2. Respiration rate/min. and percentage increase (between successive AT) in Rahmani (Rah) and Merino (M) at 8 and 16 months of age under different ambient temperatures

Ambient temp. °C	Rate / min				% increase			
	8		16		8		16	
	Rah	M	Rah	M	Rah	M	Rah	M
30	40±10	80±20	30±7	69±19	15	23	27	12
32	46±10	98±25	38±10	77±20	13	8	11	13
34	52±9	106±21	42±15	87±23	15	9	19	15
36	60±10	116±26	50±15	100±30				

This high frequency of respiration rate per minute in Merino compared to Rahmani agrees with Khalifa *et al.* (1987) and El-Ganaieny (1986). Due to the low efficiency of heat dissipation via animal surface in densely wool coated Merino, it is forced to apply further heat dissipation by water vaporization via the respiratory system than the subtropical Rahmani sheep. At 36°C ambient temperature the Rahmani rams did not show more than 80 resp./min. while Merino rams augmented their respiration rate up to 160/min., that is double to Rahmani rate (Figures 1 & 2).

Regression coefficients for rectal temperature and respiration rate on ambient temperature (Table 4) showed that this summer hot climate induced greater change in Merino than in Rahmani in that physiological responses.

Plasma bicarbonate ( $\text{HCO}_3^-$ ) Plasma bicarbonate was more concentrated in Merino than Rahmani denoted by ml of  $\text{CO}_2$ /100 ml plasma. This concentration was slightly less at younger ages in both breeds. The concentration showed negative relation with respiration rate in all cases in Rahmani going down to reach 40 ml/100 ml plasma Merino showed a characteristic trend of negative relation until RR of 110/min. with sudden change to positive relation

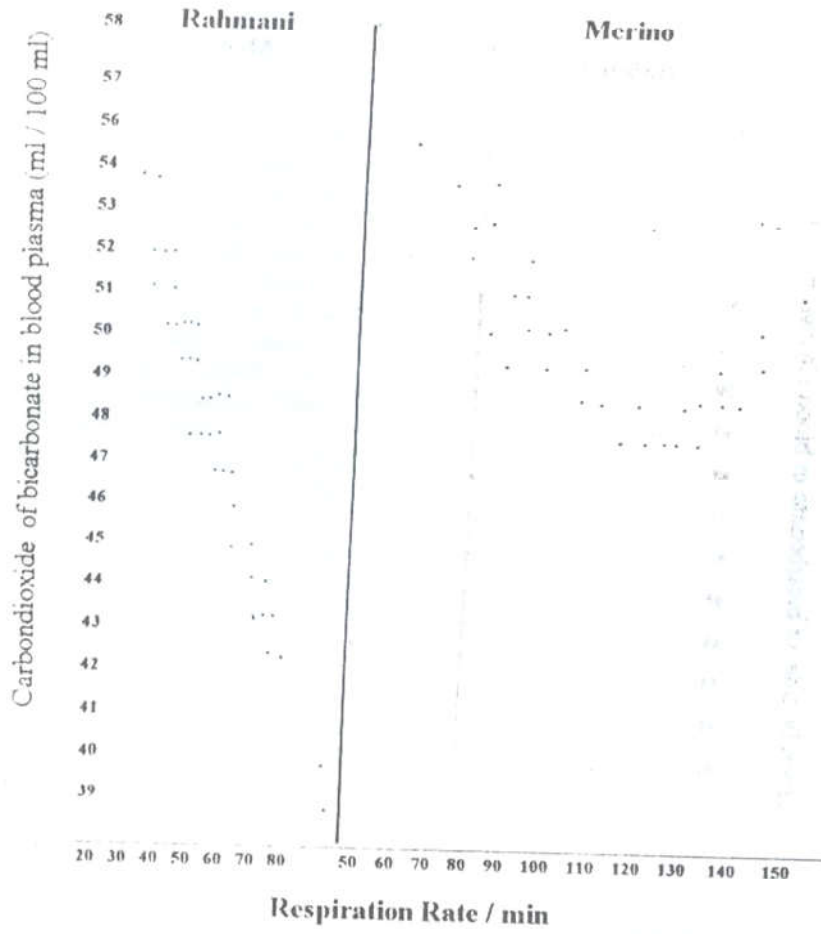


Fig. 1. Relationship between respiration rate and carbondioxide content in blood of Rahamani and Merino at 8 months of age.

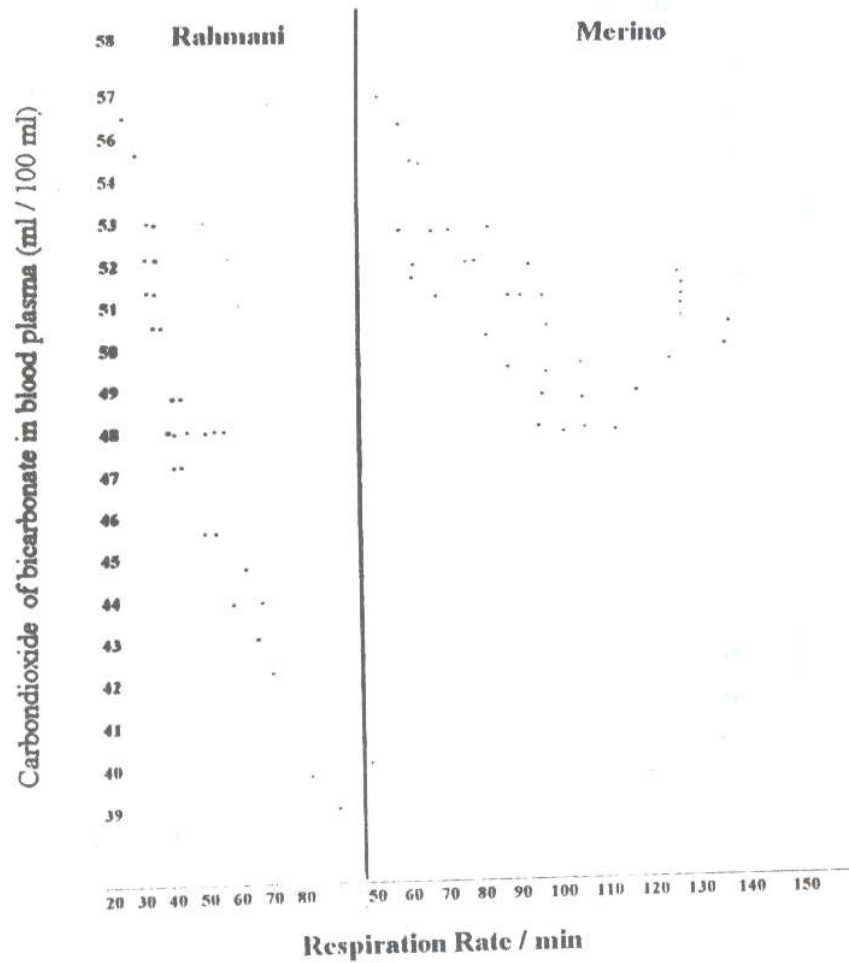


Fig. 1. Relationship between respiration rate and carbondioxide content in blood of Rahamani and Merino at 16 months of age.



thereafter (Figures 1 and 2) going up to reach 53 ml. was more concentrated in Merino than Rahmani. This concentration was slightly less at younger ages in both breeds. The concentration showed negative relation with respiration rate in all cases in Rahmani going down to reach 40 ml/100 ml pl. Merino showed a characteristic trend of negative relation until RR of 110/min. with sudden change to positive relation thereafter (Figures 1 & 2) going up to reach 53 ml.

Table 3. Carbon dioxide of bicarbonate in blood plasma (ml/100ml) and percentage of decrease in Rahmani (Rah) and Merino (M) at different ambient temperatures

Ambient temp. °C	Concentration (ml/100ml)				% Decrease			
	8		16		8		16	
	Rah	M	Rah	M	Rah	M	Rah	M
30	53±3.1	54±2.0	55±2.5	57±2.7	6	4	7	3
32	50±3.0	52±2.2	51±3.9	54±2.3	4	2	4	2
34	48±2.4	51±1.5	49±4.3	53±2.4				
36	45±3.1	51±1.5	47±3.9	52±1.8	6	0	4	2

Table 4. Regression Coefficients for rectal temperature (Bt) and respiration rate (RR) on air temperature (AI) in Rahmani (Rah) and Merino (M) at 8 and 16 months of age

Age (m.)	RT / AT		RR / AT	
	Rah.	M.	Rah.	M.
	8	0.065*	0.097*	3.350*
16	0.076*	0.098*	3.200*	3.360*

\* Significant at P. 1%.

Thompson (1985) discussed the state of respiratory ventilation in relation with ambient temperature. He stated that with rise in ambient temperature respiration rate (RR) increases accompanied with reduction in tidal volume to keep constant level of ventilation (1st

phase of reaction). With greater heat stress the animal increases both (RR) and tidal volume (in struggle to increase more water vaporization (2<sup>nd</sup> phase of reaction) thus increasing rate of ventilation in the respiratory (alveolar) space. This phase leads to putting out more CO<sub>2</sub> from the body causing alkalosis case. Based on researches in cattle and sheep Thompson (1985) stated that pH of arterial blood may reach 7.7, a case of high respiratory alkalosis.

The low frequency of respiration in Rahmani alongside the larger dead space and smaller respiratory space than in Merino as reported by Shafie and Abdelghany (1978) enables Rahmani to adjust the tidal respiratory volume than Merino.

It seems, in the present study, that Rahmani was successful in maintaining the 1<sup>st</sup> phase of ventilation under all the studied levels of ambient temperature while Merino passed to the 2<sup>nd</sup> phase. Thus Rahmani kept normal ventilation rate in the alveolar size, controlling the output of CO<sub>2</sub> from the blood and maintaining the buffer system HCO<sub>3</sub><sup>-</sup>/H<sub>2</sub>CO<sub>3</sub> for acid-base balance. This mechanism seems to be well fulfilled in Rahmani by reduction in HCO<sub>3</sub><sup>-</sup> ion in parallel with any reduction of H<sub>2</sub>CO<sub>3</sub> by faster output of CO<sub>2</sub>.

The present study proved that RR did not exceed 80/min in Rahmani at which the bicarbonate CO<sub>2</sub> was 39-40 ml/100 ml plasma, at such rate (80/min.) in Merino the CO<sub>2</sub> was 52- 54 ml. This means that Merino has one third more concentration of bicarbonate ion (HCO<sub>3</sub><sup>-</sup>) in its plasma than the local subtropical breed at 80 resp./min.

Under high ambient temperature sheep, particularly those of temperate zone, are exposed to a very critical condition struggling to keep their vital internal physical conditions particularly body temperature and pH. In this condition all the physiological activities of animals are directed toward this goal. Due to subtropical sheep adaptability to high ambient temperature, it could reach homeostatic condition with less physiological activity of respiration which enable it to maintain both body temperature and blood pH in the normal range.



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## الاستجابة الحرارية التنفسية لآنواع الاغانم المحلية والمستوردة لظروف حرارة الصيف فى مصر

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اجرى هذا البحث لمقارنة استجابة درجة حرارة الجسم ومعدل التنفس وتركيز بيكربونات الدم لآنواع الاغانم الرحمانى والمرينو تحت ارتفاع حرارة الصيف ( فى منتصف اليوم ) ابتداء من ٣٠ م° الى ٣٦ م° . استخدم فى هذا الدراسة ٥ كباش عند عمر ٨ شهور ونفس العدد عند ١٦ شهر من العمر لكلا النوعين .

الزيادة فى حرارة البيئة سببت زيادة كبيرة فى درجة حرارة الجسم فى المرينو عنه فى الرحمانى بمعدل ٠,٦ الى ٠,٤ م° على الترتيب .

معدل التنفس اوضح فروق كبيرة بزيادة من ٤٠ الى ٦٠ مرة/دقيقة فى الرحمانى بينما فى المرينو ارتفع المعدل من ٨٠ الى ١١٦ وذلك فى أعمار ٨ شهور والقيم المناظرة لمعدل التنفس للذكور عند عمر ١٦ شهر كانت ٣٠-٥٠ مرة/دقيقة للرحمانى بينما ارتفع من ٦٩ الى ١٠٠ للمرينو .

بيكربونات الدم انخفضت كلما زاد معدل التنفس فى الرحمانى باستمرار . بينما فى المرينو انخفضت بيكربونات الدم كلما زاد معدل التنفس حتى ١١٠ مرة/دقيقة ثم ارتفع مستوى البيكربونات مع الزيادة فى معدل التنفس .

وقد نوقشت النتائج من مفهوم توازن ( حمض - قاعدة ) وعلاقته بالحفاظ على الدرجة الطبيعية لحموضة وقلوية الدم .